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Docket Management System
U. S. Department of Transportation
Room Plaza 401
400 Seventh Street, SW
Washington, D.C. 20590-0001

Reference: Docket Number FAA-2003-14449
Notice of Proposed Rulemaking; Enhanced Flight Vision Systems

Rockwell Collins is the developer and manufacturer for the preponderance of Head-Up Display (HUD) systems in current commercial service in both U.S. and European airspace. The docket for comments on the above cited proposed rule is currently open for comments until March 27th, 2003.

The proposed rule requires a HUD for display of the enhanced vision scene, along with certain aircraft flight information. Rockwell Collins strongly supports initiatives to bring forward new technology which can enhance the safety and efficiency of aviation operations. Rockwell Collins submits the attached comments to the proposed Rule.

[Original Signed By:]

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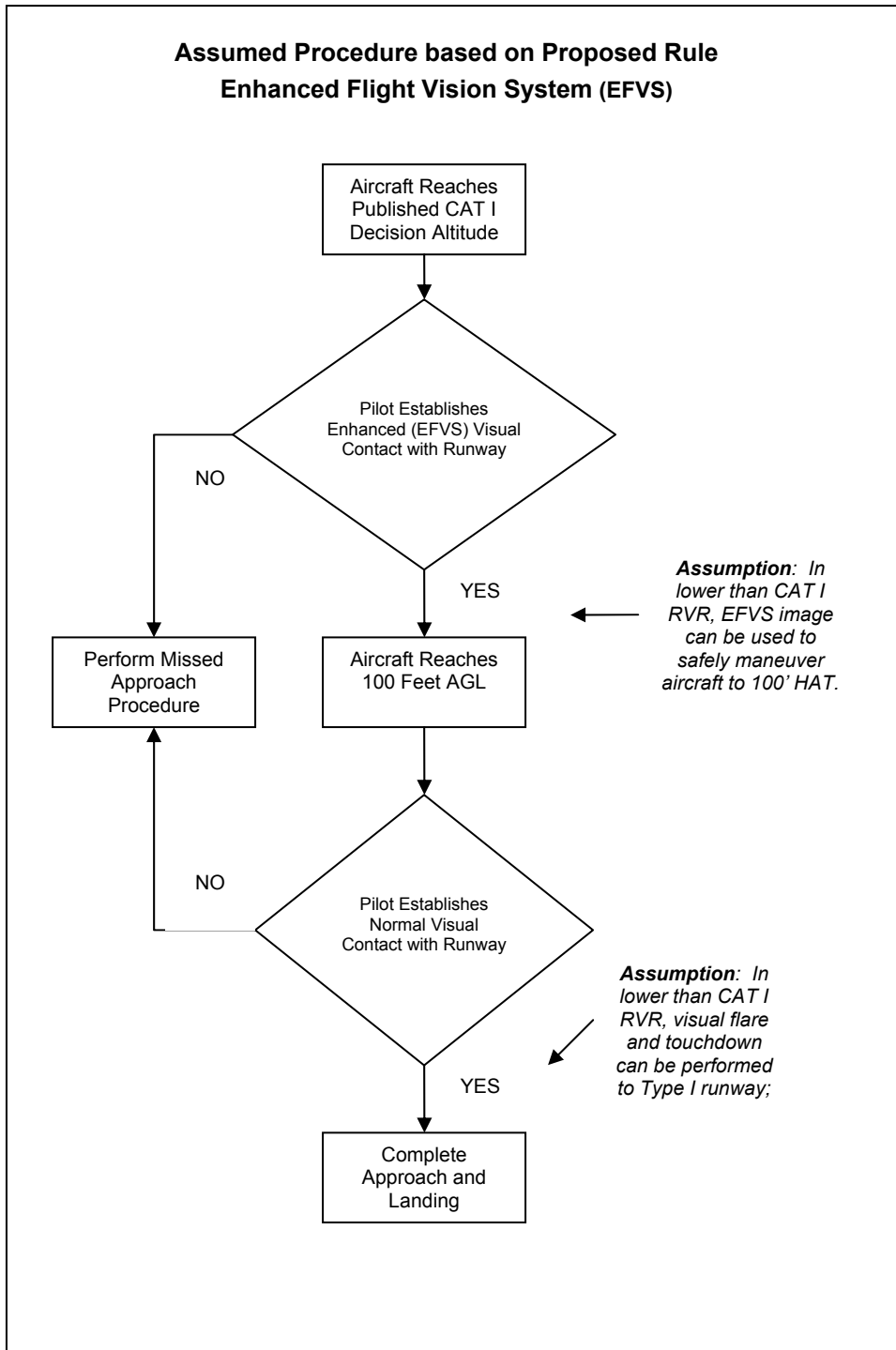
Comments on Enhanced Flight Vision Systems; Proposed Rule

Rockwell Collins (hereinafter RC) finds that enhanced vision technologies can offer improvements in the safety of aircraft operations during certain phases of flight and ground maneuvers. RC supports the FAA efforts to bring these technologies into more widespread use. Pertinent comments and observations contained in the following paragraphs discuss operational intent of the proposed rule, use of a Head-Up Display (HUD) for this operational intent, conformal HUD image presentation, HUD guidance symbology appropriate to the approach and landing task, technological characteristics of the image source, and the need for Advisory Material in support of the proposed rule.

1. Operational Intent

In normal IFR operations, Part 91.175 requires that the pilot have clear and unobstructed visibility of the approach lights to continue below the DA, DH, or MDA. The NPRM seeks to augment the visibility requirement by permitting the use of a sensor-based imaging device in conjunction with a HUD to enhance the pilot's visibility down to the 100 foot level, at which altitude the existing visibility requirements of 91.175 again become the operant rule, and the pilot must make the decision whether to go around or to land the airplane based on unassisted visual references only (not based on the EFVS imagery). The types of approach procedure involved are typically to 200 foot minimum decision height facilities (see Assumed Procedure flowchart on following page). The proposed rule applies primarily to "fly down and take a look" approach operations.

Operators of Part 121 and Part 135 aircraft would not be permitted to initiate the type of approach which is the subject of the proposed rule, due to existing minima requirements. The type of operation intended in the proposed rule is characterized by the pilot's not having a clear and unassisted view of the runway at 200 feet of altitude above runway elevation, and therefore the visibility for the type of operation addressed by the NPRM could be considered as less than current Cat I requirements. The type of operation intended could, therefore, be interpreted as a Cat II approach by some regulatory organizations, which may complicate application of the final rule without further clarification. In order to avoid controversy in application of the proposed rule, the operational intent should be clarified, to include specific visibility requirements.



2. Use of Head-Up Display –

The proposed rule should continue to require the use of a HUD by the Pilot Flying as the primary display medium for through-the-window vision of the real-world scene:

- Systems which assist pilot vision of the outside scene (e.g., EFVS) must employ a head-up display. Head-down displays are an inappropriate mechanism for technologies intended to assist the pilot in achieving a required-by-regulation out-the-window view of the real-world scene because of the increased transition and accommodation times associated with the head-down to head-up transition.

The period between the decision phases of an EFVS approach operation is essentially concerned with the descent from 200 feet to 100 feet on an ILS beam. This encompasses a time span of only 8 to 10 seconds, a time period too short, and at an altitude too critical, to require a pilot view that continually switches from head-down to head-up.

There may be operational conditions where an out-of-the window view may not be required, and where display of a vision system image on a head-down device has merit. Monitoring of the EFVS image, displayed head-down, by the Pilot Not Flying, could, for example, improve the situational awareness of that crewmember in the low-visibility approach procedure.

Possible head-down display of the vision system image is not addressed in the proposed rule and is not a subject of this NPRM, although several operational scenarios for future head-down applications can be envisioned within the context of standard IFR operations, surface operations, etc. It is recommended that the FAA consider the application of head-down displays for other than single pilot operations in subsequent Advisory Material.

3. Conformal Presentation –

Based upon the considerable body of research and development in the area of Head-Up Display technology and application, conformal imagery is essential to HUD usage envisioned by the proposed rule. The vision system must be conformal in order to mitigate visual transition effects, and to ensure compatibility with any use of conformal symbology displayed concurrently with the EFVS image. The proposed rule should be amended to require conformal imagery:

- The displayed vision system image must be reasonably conformal to the outside scene (e.g., not scaled up or down, not of wider angular field, etc.). Flight instrument information content must be presented concurrently with, but visually separable from, the vision system image, using conformal symbology (where applicable).

4. Required Guidance –

The introductory material to the proposed rule states “An EFVS proposed for use under this proposed rule would have to provide the pilot with sufficient guidance and visual cues so that the pilot could manually maneuver the aircraft to a landing on the intended runway”. The proposed rule does not contain text detailing the nature of “sufficient guidance” and, in fact, does not appear to require any form of guidance.

EFVS implementations using current generation infrared sensors cannot guarantee visual penetration of the cloud base. As a result, the cloud ceiling height may be more significant than horizontal RVR near the runway surface for EFVS operations. Above the cloud base, raw beam deviation data and some form of flight director or ‘command guidance’ should be essential to the type of operation anticipated where unassisted visual contact with the runway is not established.

The Flight Safety Foundation, in a recent worldwide study of fatal Approach-and-Landing Accidents (ALAs), found that the leading causal factors were continuance of the approach below decision height (or minimum descent altitude) in the absence of adequate visual cues, and lack of positional awareness in the air; where a disproportionate number of these accidents have occurred at night. Studies of the factors in unstabilized and missed approaches in general show that about 75% of these incidents are either low and/or slow, or high and/or fast during the approach.

Clearly, situational awareness is critical during the type of operation anticipated. The HUD display should include a conformal presentation of the velocity vector of the aircraft (e.g., conformal display of inertial flight path guidance to the projected touchdown on the runway), to ensure that the pilot has adequate lateral and descent path control and subsequent flare reference. Without guidance information below 200 feet, the pilot would have only visual cues from the imagery, which are not adequate to mitigate the effects of winds and turbulence or to provide sufficient situational awareness in the anticipated low visibility scenario.

In terms of situational awareness, the display should include elements which represent the energy state of the aircraft (e.g., angle-of-attack, reference speed control presentation, acceleration/deceleration presentation). Energy state and airspeed error are essential for a stable approach leading to a consistent and repeatable touchdown. This is achievable on a manually flown HUD through precise airspeed control and inertial flight path presentation.

The proposed rule must be amended to include a requirement for sufficient additional symbology to meet the intent for ‘guidance’ as stated in the introductory material:

- Symbology which overlays the displayed vision system image must include sufficient situational awareness components to clearly present the flight path and the energy state of the aircraft to the pilot.

'Guidance' suitable to fly the approach to 100 feet should be defined in detail in Advisory Material. Appropriate symbolic guidance components for this purpose could include flight director guidance, conformal horizon, attitude, altitude, inertial flight path, airspeed and airspeed error, as well as computed rate-of-change (acceleration/deceleration) information, and angle-of-attack information.

5. Technological Characteristics

The proposed 91.175 (m) (1) of the rule, which addresses features and characteristics states: "An electronic means to provide a display of the forward external scene topography (natural or manmade features of a place or region especially in a way to show their relative positions and elevation) through the use of imaging sensors, such as a forward looking infrared, millimeter wave radiometry, millimeter wave radar, and low-light level image intensifying;". Similar wording also appears in the EFVS definition of Part 1.1. Neither the rule nor the definition should cite specific current-generation technology, but rather should reflect a performance or implementation requirement which can be further developed in Advisory Material. For example:

- The sensor-based imaging elements of the EFVS shall be appropriately located on the aircraft, shall employ a sensor technology appropriate to the intended function, and the combination of the sensor and HUD shall provide resolution and other system attributes coincident with the generation of a high-quality conformal image.

6. Need for Advisory Material

New Advisory Material should be developed to support the proposed rule. The development of new Advisory Material need not delay adoption of a suitable enhanced vision system rule.